DoD EPA DOE SERDP
Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

US Army Corps of Engineers®

SERDP's SEMP

Ecosystem Management Project

CS-1114

Mr. William Goran, SEMP Project Manager
Dr. Penelope Firth, Chair, SEMP Technical Advisory Committee

SERDP Scientific Advisory Board

12 March 2003

Purposes of SEMP

- **To provide land managers with resources and tools to understand and better manage their installations**

- **To support sustainable mission use and improved stewardship of military lands**

Technical Objectives

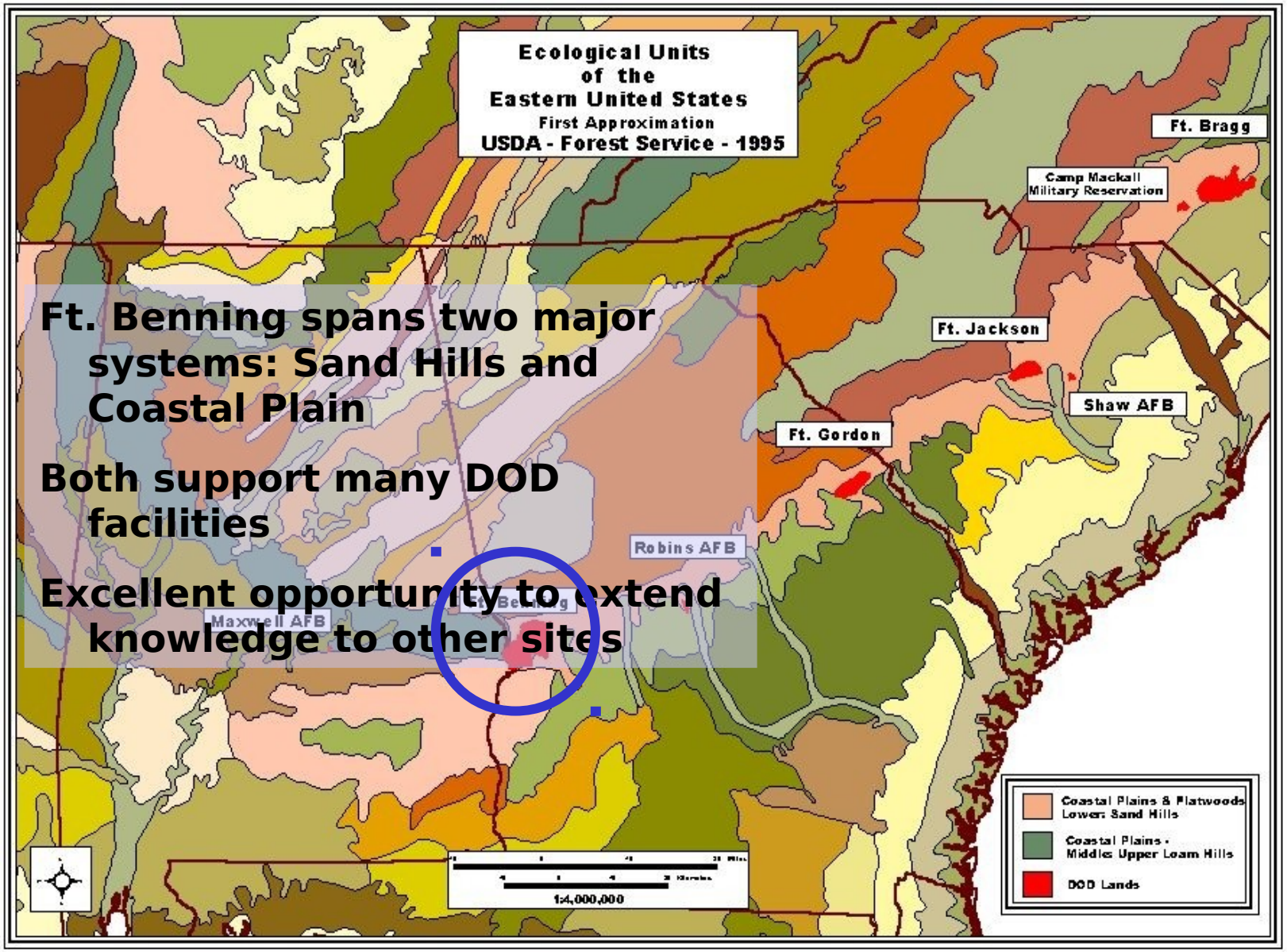
- **To address DoD requirements and opportunities in ecosystem management research (1997 SERDP Ecosystem Science Workshop)**
  - **Indicators of ecosystem status**
  - **Ecological thresholds**
  - **Role of manipulating biogeochemical cycles**
  - **Importance of spatial/temporal scales**

- **To establish a long-term research site (or sites) on DoD lands for DoD relevant ecosystems research**

- **To conduct ecosystem research and monitoring activities relevant to DoD requirements and opportunities**

- **To facilitate the integration of findings and results of research into DoD ecosystem management practices**

SEMP Research Site



Ft. Benning spans two major systems: Sand Hills and Coastal Plain

Both support many DOD facilities

Excellent opportunity to extend knowledge to other sites

Priority research areas (1997 SERDP workshop)
Indicators of ecosystem status
Ecological thresholds
Role of manipulating biogeochemical cycles
Importance of spatial/temporal scales

SEMP Approach

Research Themes

competitive selection

Research Projects

publication and feedback

analysis of findings

integration of efforts

validation and testbedding

Integrated Tools

Monitoring Activity (ECMI)
Data Repository
Other Research Projects
Installation Needs and Data

Installation Capabilities
Management Requirements

handoff / tech-transfer

Installation Ecosystem Management Plans and Practices

Next: Franchise SEMP Approach to Other Installations

Technical Advisory Committee

Dr. Mary Barber, Ecological Society of America, SERDP SAB Member
Mr. Peter Boice, Director of Conservation Programs, Office of the Deputy Undersecretary of Defense, Installations & Environment
Dr. Neil Burns, US Environmental Protection Agency, Region 4
Mr. George Carellas, Chief, Southeastern Regional Office, US Army Environmental Center
Dr. Brian Czech, Headquarters, U.S. Fish and Wildlife Service
Dr. Roger Dahlman, Program Manager, U.S. Department of Energy, SERDP Conservation Working Group Member
Dr. Penny Firth, National Science Foundation (Chair)
Dr. John Hall, The Nature Conservancy
Mr. Ray Johnston, U.S. Department of Agriculture, Forest Service
Dr. L. Katherine Kirkman, Joseph W. Jones Ecological Research Center

SEMP Oversight and Management from the TAC Perspective

Structure

2002 - 2003

Function

Vision

SEMP Oversight and Management from the TAC Perspective

Structure

Chair elected from TAC membership

Executive Secretary assigned to TAC

TAC balance addressed

TAC service terms regularized

SEMP Oversight and Management from the TAC Perspective

Function

Role of TAC clarified with guidance from SERDP

Unified reporting mechanisms implemented for SEMP pro

TAC evaluation and recommendation approach regularize

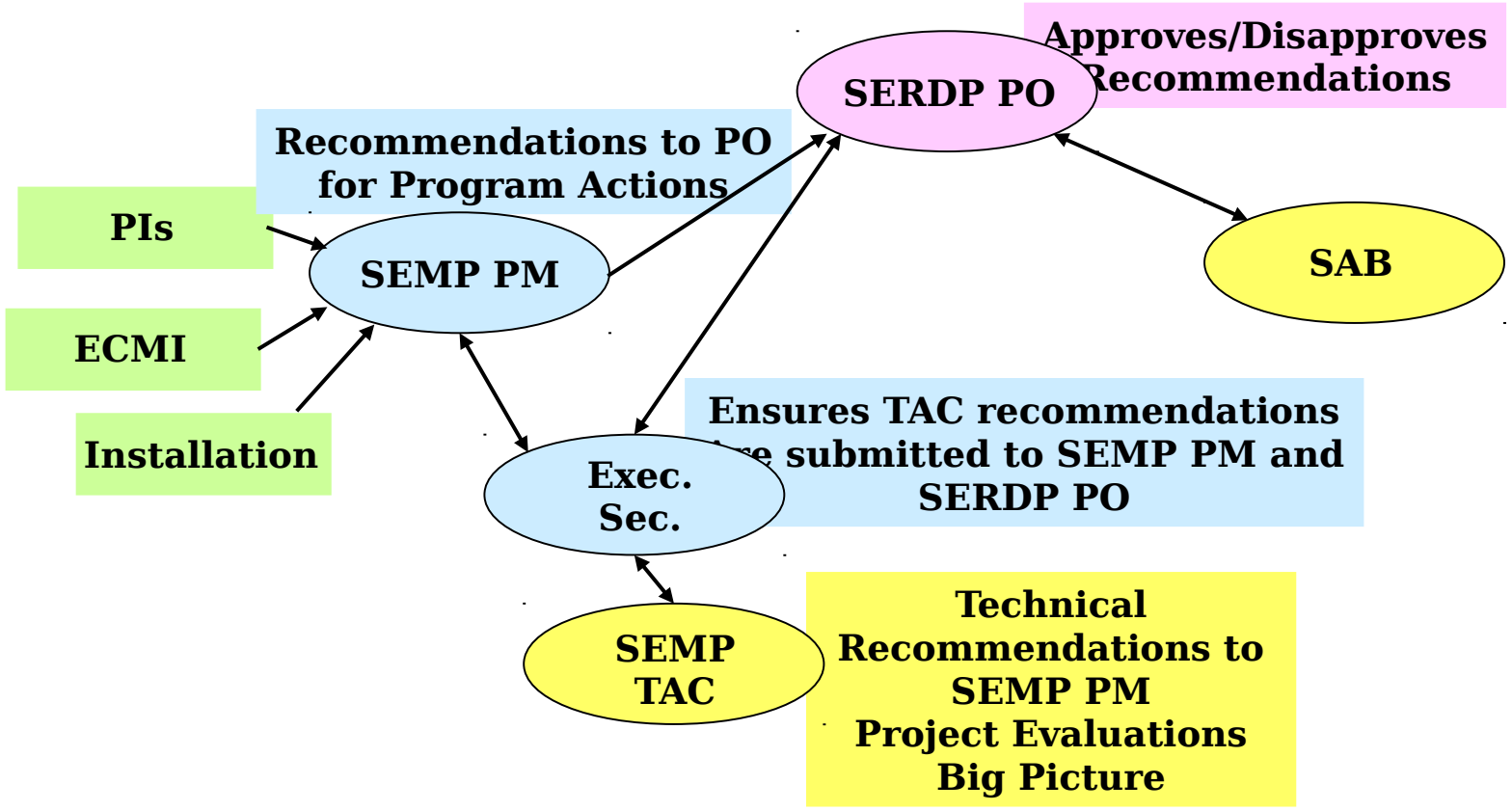
ERDC management team strengthened and interface wit
TAC clarified with guidance from SERDP

SEMP Oversight and Management from the TAC Perspective

Functio

Role/Responsibilities of SEMP and SEMP TAC

Guidance provided by Jeff Marquese, October 2002



SERDP
Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

SEMP Oversight and Management from the TAC Perspective

Function

Role/Responsibilities of ERDC Mgmt Team

US Army Corps of Engineers®

Program Manager – Mr. William Goran
Research Coordinator* – Dr. Harold Balbach
Monitoring – Dr. David Price
Tech Transfer Coordinator* – Dr. Jeffrey Fehmi
Data Repository – Dr. Rose Kress
Host Site Coordinator – Mr. Hugh Westbury
SEMP Reporting – Ms. Teresa Aden

* New Roles

SEMP Oversight and Management from the TAC Perspective

Vision

SEMP charged by TAC Chair with addressing two issues in the near term:

Integration

Handoff

SEMP Oversight and Management from the TAC Perspective

Vision

Integration efforts include:

PI Meetings
Site Condition Index – terrestrial and aquatic
Annual research coordination meetings
Integration plan

SEMP Oversight and Management from the TAC Perspective

Vision

Handoff efforts include:

Coordination with INRMP
Assignment of Tech Transfer Coordinator
Data repository
Integration plan

SEMP Oversight and Management from the TAC Perspective

Vision

SEMP needs to actively pursue long-range vision:

Validation

Franchising

SEMP Research Projects

Indicators Projects

ORNL	Dr. V. Dale	Indicators of Ecological Change
U. Florida	Dr. K.R. Reddy	Determination of Indicators of Ecological Change
Prescott Coll.	Dr. T. Krzysik	Development of Ecological Indicator Guilds for Land Management

Thresholds Projects

ORNL	Mr. C. Garten	Disturbance of Soil Organic Matter and Nitrogen Dynamics: Implications for Soil and Water Quality
U. Georgia	Dr. B. Collins	Thresholds of Disturbance: Land Management Effects on Vegetation and Nitrogen Dynamics

Determination of Indicators of Ecological Change

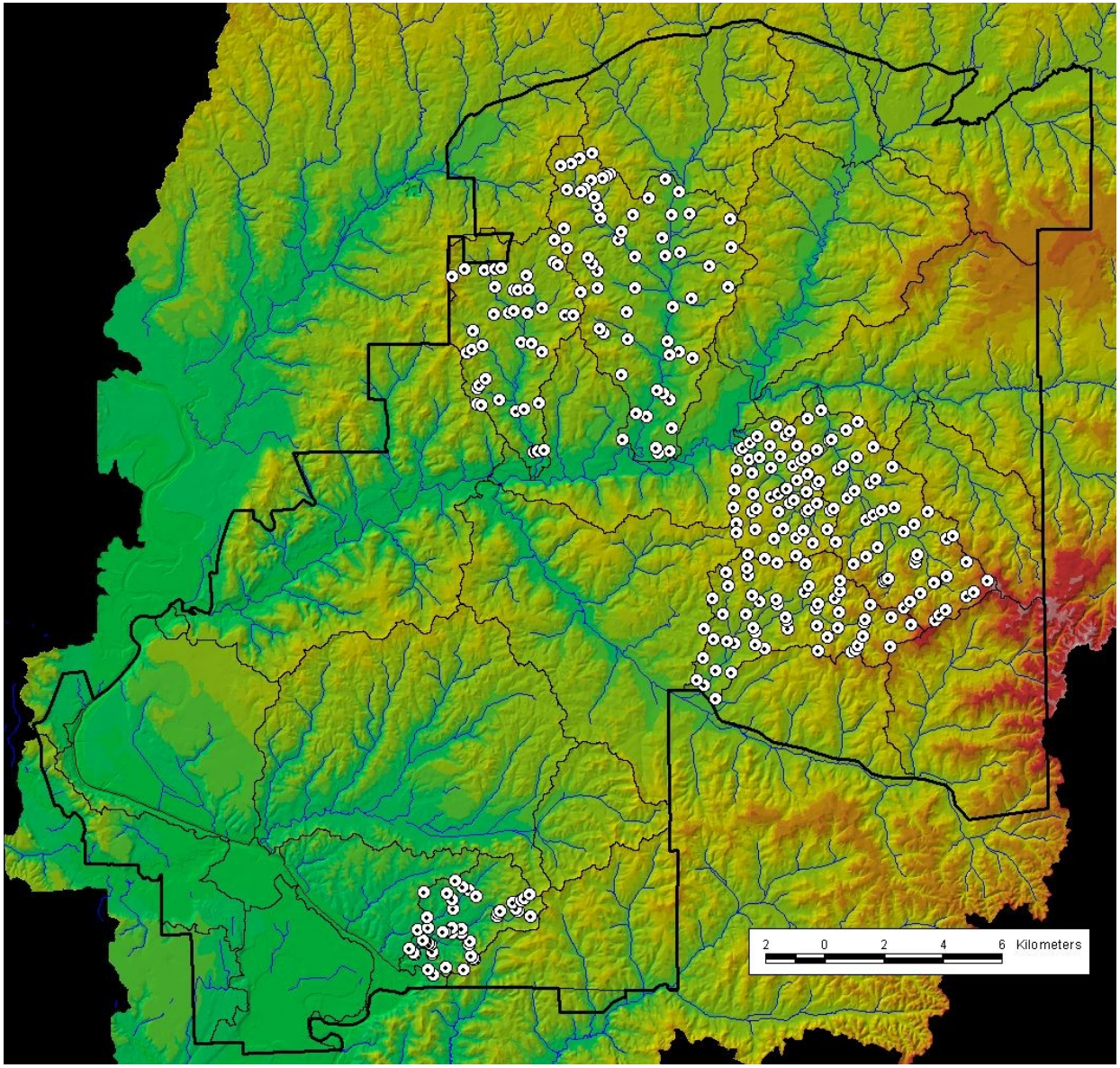
CS-1114A-99

- **Dr. K. Ramesh Reddy, University of Florida, Gainesville, FL**

- **Goal: to develop suitable indicators of ecosystem integrity and impending ecological change resulting from both natural variation and anthropogenic activities**

- **Method: Evaluate a suite of parameters related to properties and processes in the soil, under story vegetation and surface hydrology at multiple scales**

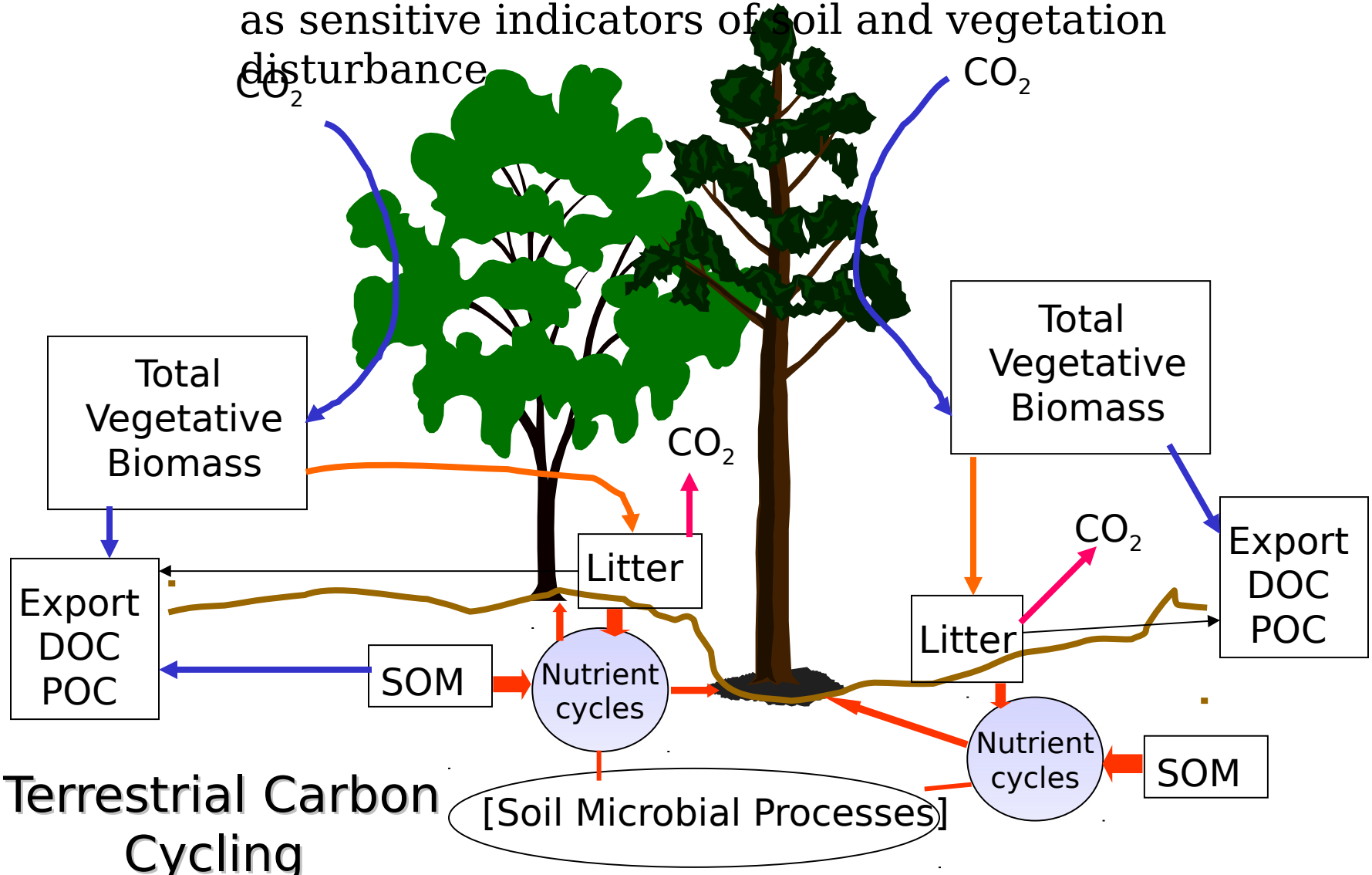
Field Sampling Locations



Parameters

pH
Total C **Water Extractable C** **Microbial C** **Soil respiration (CO_2 prod.)**
Total N **Exchangeable NH_4^+** **Microbial N** **PMN** **Arginine ammonification**
Total P **Water Extractable P** **HCl Extractable P** **Oxalate Extractable P** **Mehlich-1 P** **Microbial P**
Mehlich-Fe, Al, Ca, Mg, K **Oxalate-Fe, Al**
Acid Phosphatase **Beta-Glucosidase** **Dehydrogenase** **Protease** **Microbial diversity**

Parameters related to soil organic matter and microbial biomass / activity have shown promise as sensitive indicators of soil and vegetation disturbance

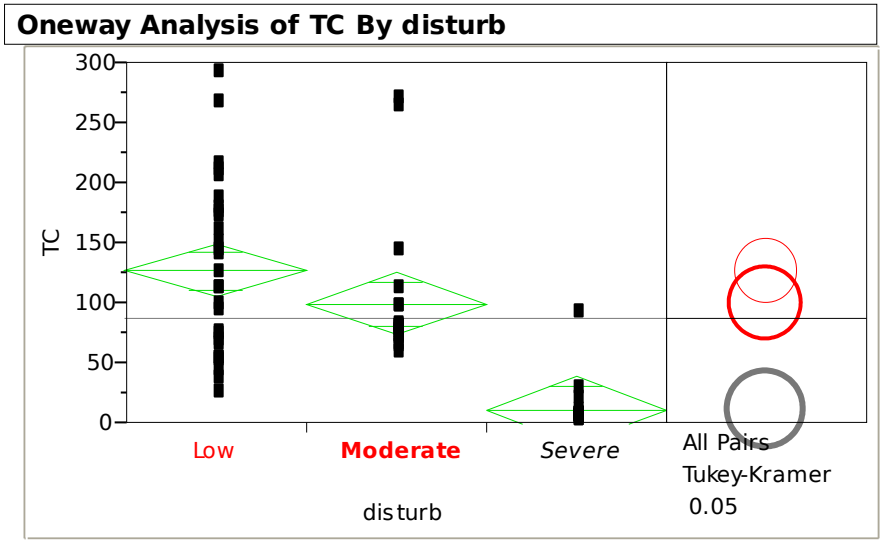


Terrestrial Carbon Cycling

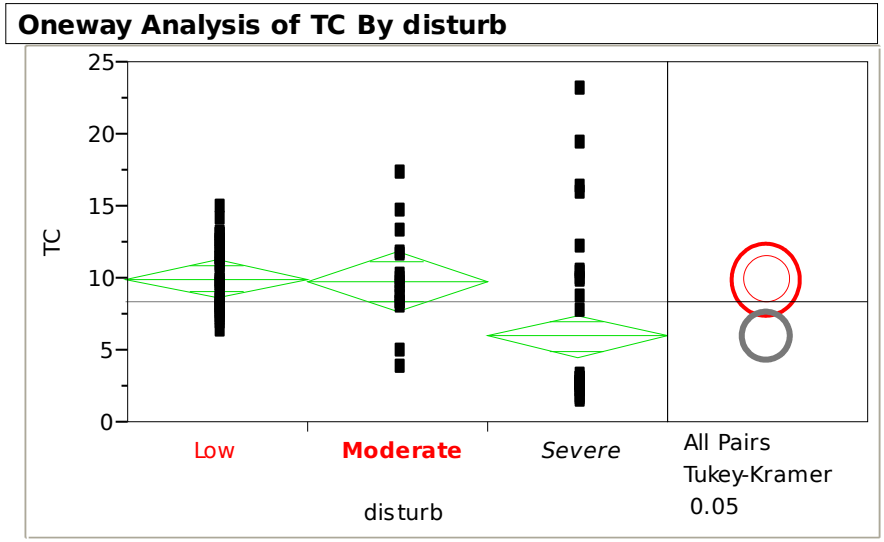
TOTAL ORGANIC CARBON

transects

Wetlands



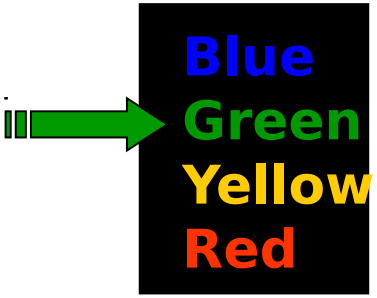
Uplands



TAC Recommendations

2002 Fall Meeting

Reddy (U Florida) Determination of Indicators of Ecological Change



Integrate project components
Address benefit of vegetation component
Publish results

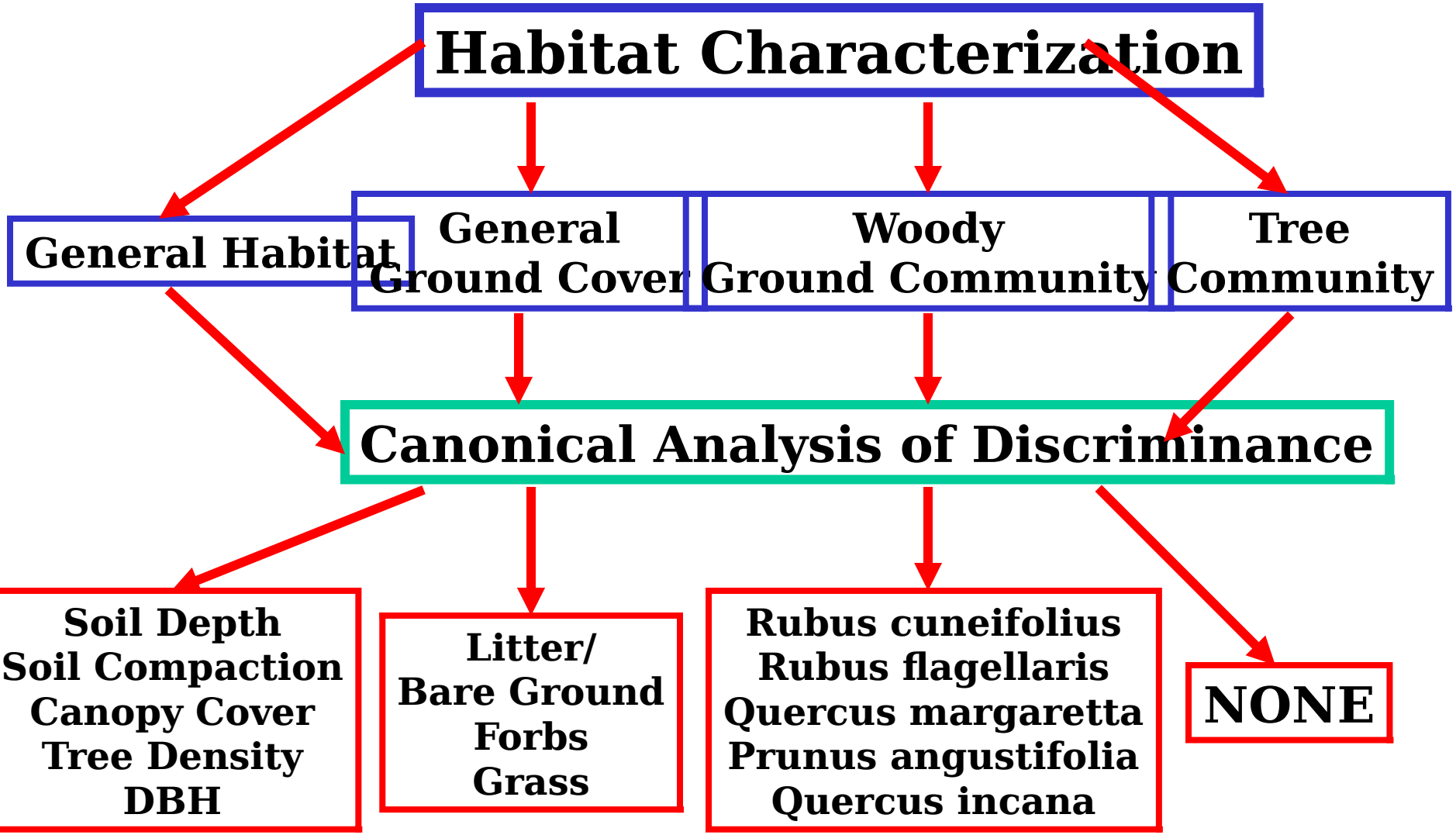
Development of Ecological Indicator Guilds for Land Management

CS-1114B-99

- **Dr. Anthony J. Krzysik, Prescott College, Prescott, AZ**

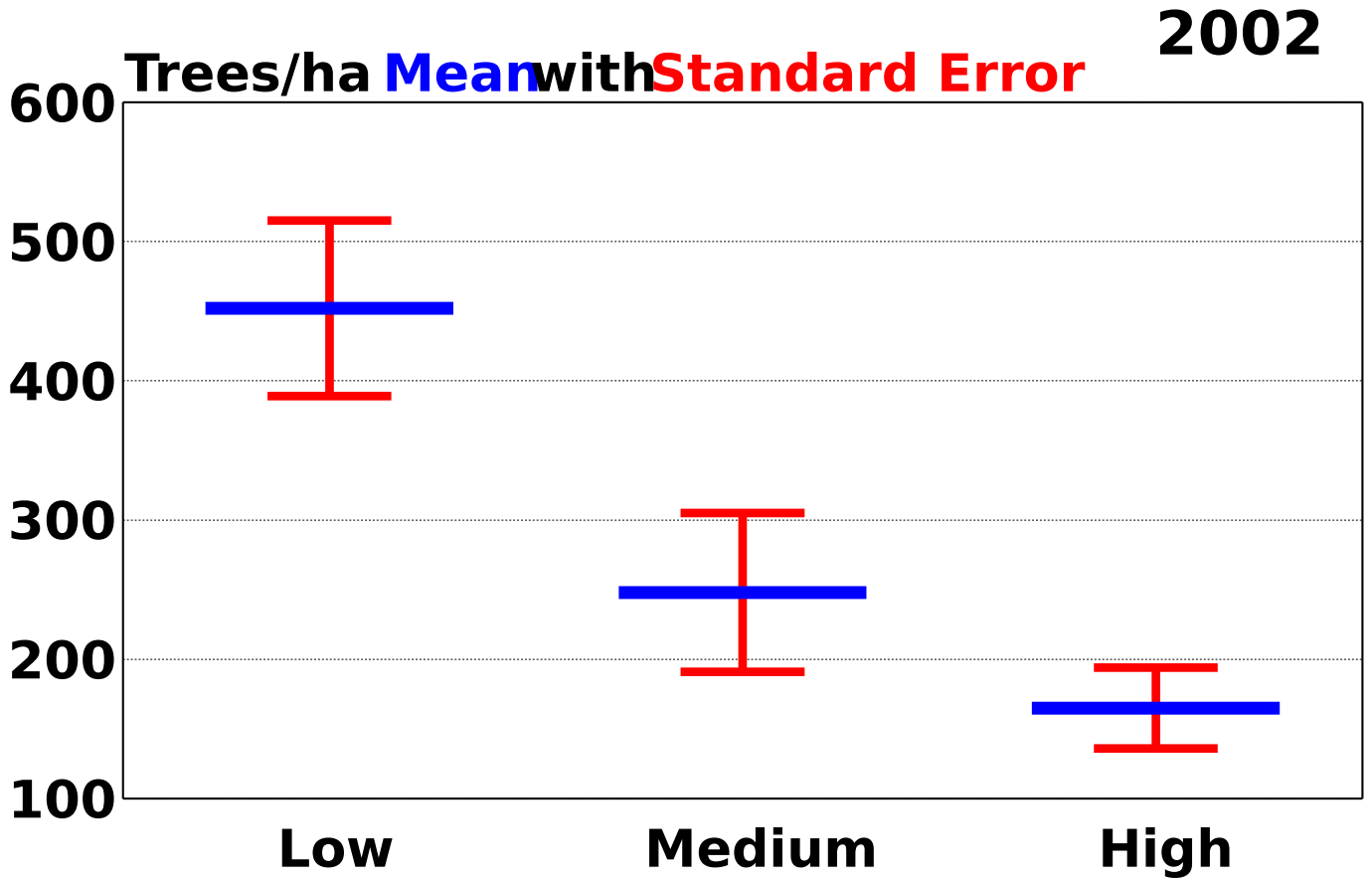
- **Goal: To develop Ecological Indicator Guilds for the purpose of monitoring ecological changes relevant to biological viability, long-term productivity, and sustainability of military training and testing lands**
- **Hypothesis: Stress responses of structural ecosystem elements may be clustered as "guilds" to provide indicators of change relevant to land use and mission activities**
- **Method: Assemble guilds from responses to ten indicator systems measured along ecosystem gradients. Systems include soil microbial activity, ecofunction group, indicator taxa, community integrity & statistical integration across systems**

Constructing Ecological Indicator Guilds



Tree Density

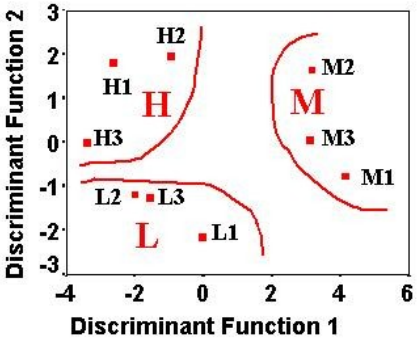
DBH > 5 cm



Low > Medium = High P=0.026

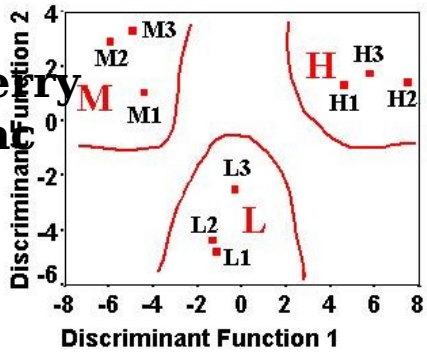
Habitat Characterization With Discriminant Analysis Using 4 Habitat Parameter Sets

Ground Cover



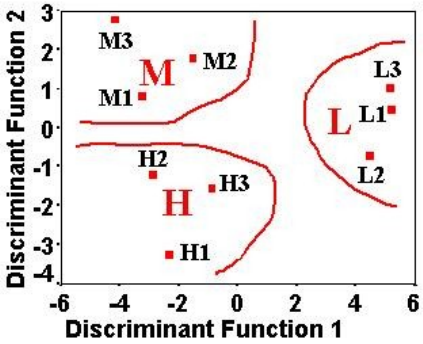
Percent: forbs, grass litter, bare ground

Woody Ground Cover



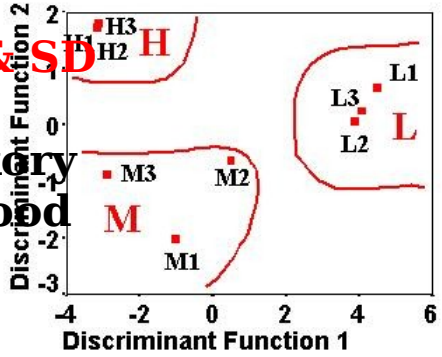
Percent:
sand blackberry
winged sumac
yellow haw
poison ivy

General Habitat



Mean & SD:
soil compaction
A-horizon soil depth
canopy cover

Tree Community

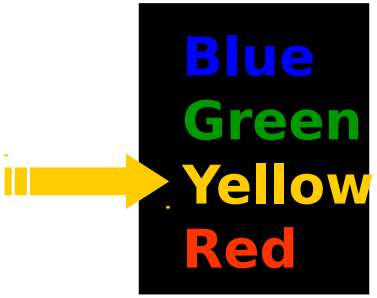


Density, Mean & SD of DBH:
mockernut hickory
flowering dogwood
hawthorn

TAC Recommendations

2002 Fall Meeting

Krzysik (Prescott College) Development of Ecological Indicator Guilds for Land Management



Stop data collection
Prepare publications
Improve communication of methods

Indicators of Ecological Change
CS-1114C-99

- **Dr. Virginia H. Dale, Oak Ridge National Lab, Oak Ridge, TN**

- **Goal: To identify indicators that signal ecological change in intensively and lightly used ecological systems that will improve installation land managers' ability to identify and prevent long-term, negative effects.**

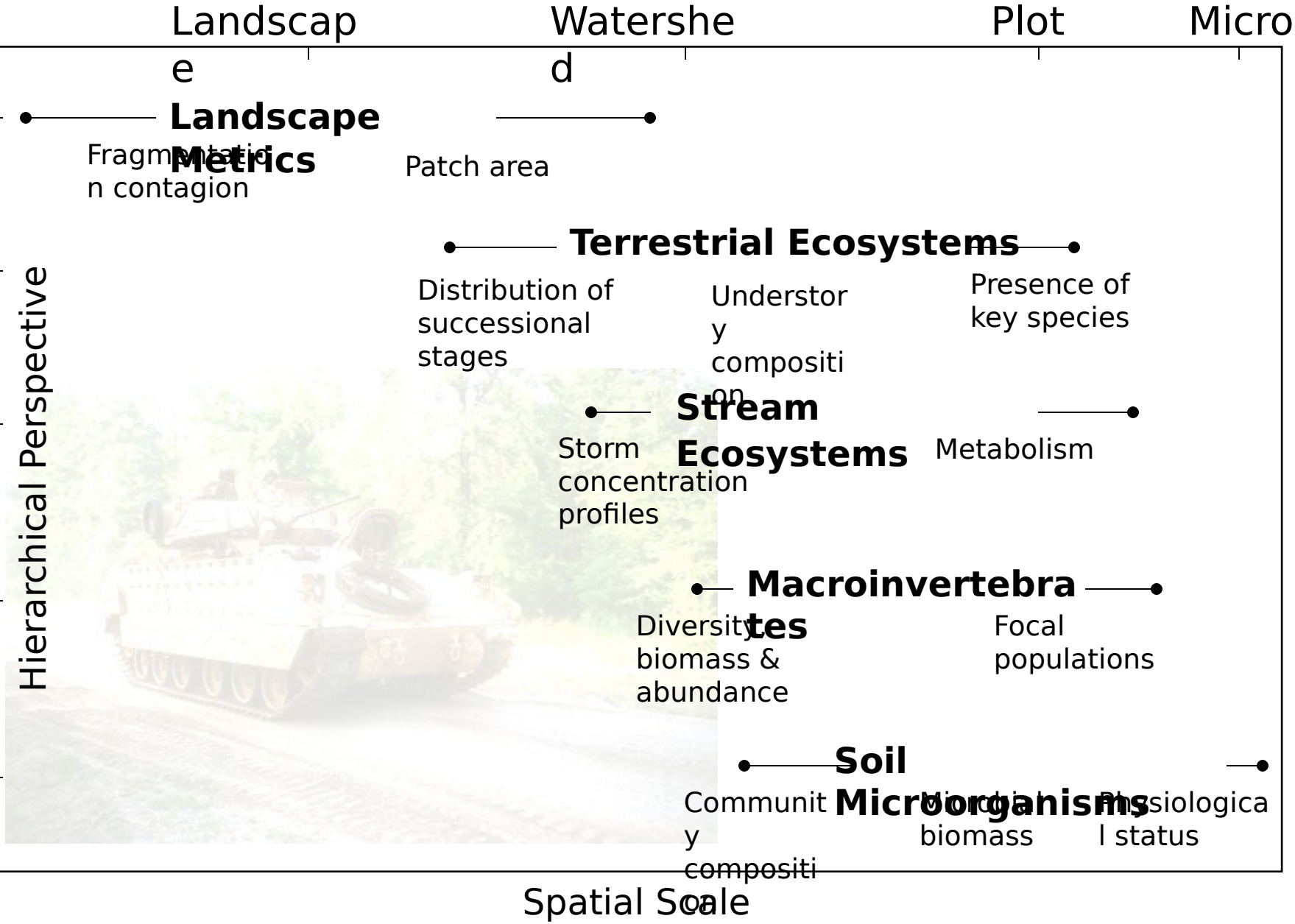
- **Method: (1) Analyze historic trends to identify potential indicators, (2) collect supplemental data, (3) perform experiment to examine how disturbance at Benning impacts these indicators, (4) analyze the results, and (5) transfer results to host site (and others)**

Criteria for Indicators*

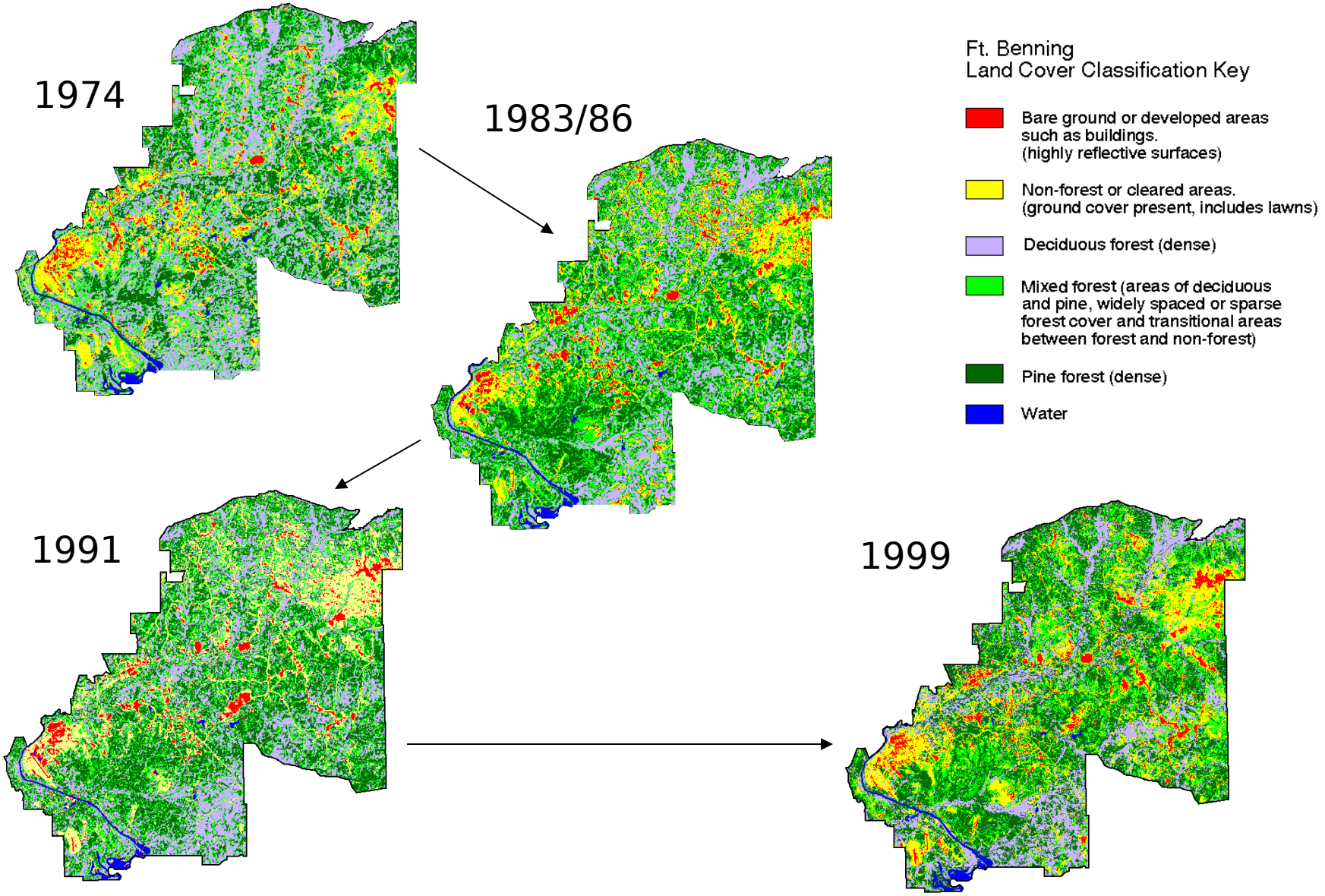
- **Are easily measurable**
- **Are sensitive to stresses of system**
- **Respond to stress in a predictable manner**
- **Signify an impending change in key characteristics of the ecological system**
- **Experience changes that can be averted by management actions**
- **Together with the full suite of indicators, provide a measure of coverage of the key gradients across the ecological systems (e.g., soils, vegetation types, temperature, etc.)**
- **Have a known response to natural disturbances and changes over time**
- **Have low variability in response**

*** Dale, V.H and Beyeler, S.C. 2001. Challenges in the development and use of ecological indicators. *Ecological Indicators*, v.1**

Suite of Ecological Indicators



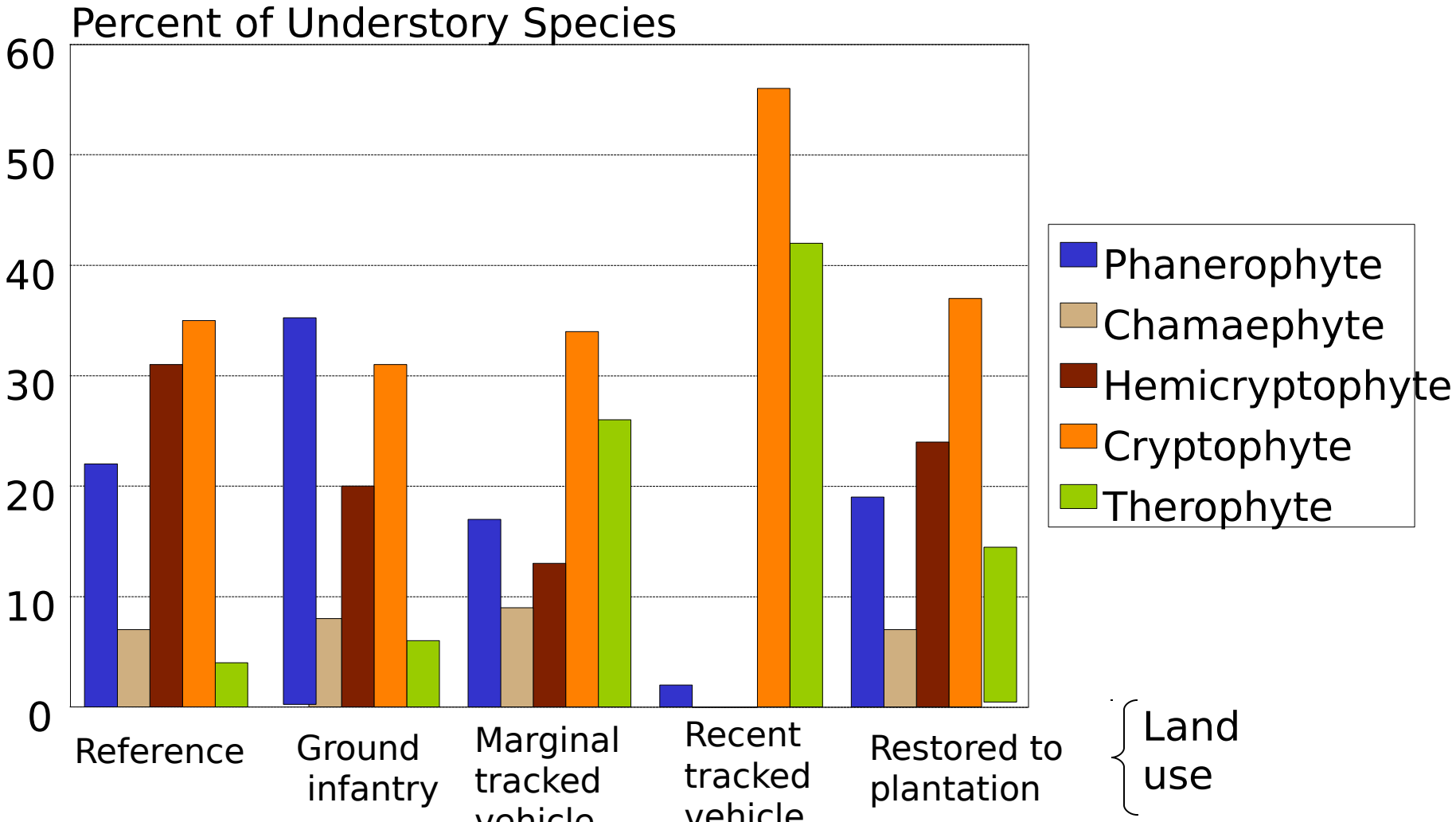
Landscape Analysis


1974
1983/86
1991
1999
Ft. Benning
Land Cover Classification Key
Bare ground or developed areas such as buildings. (highly reflective surfaces)
Non-forest or cleared areas. (ground cover present, includes lawns)
Deciduous forest (dense)
Mixed forest (areas of deciduous and pine, widely spaced or sparse forest cover and transitional areas between forest and non-forest)
Pine forest (dense)
Water

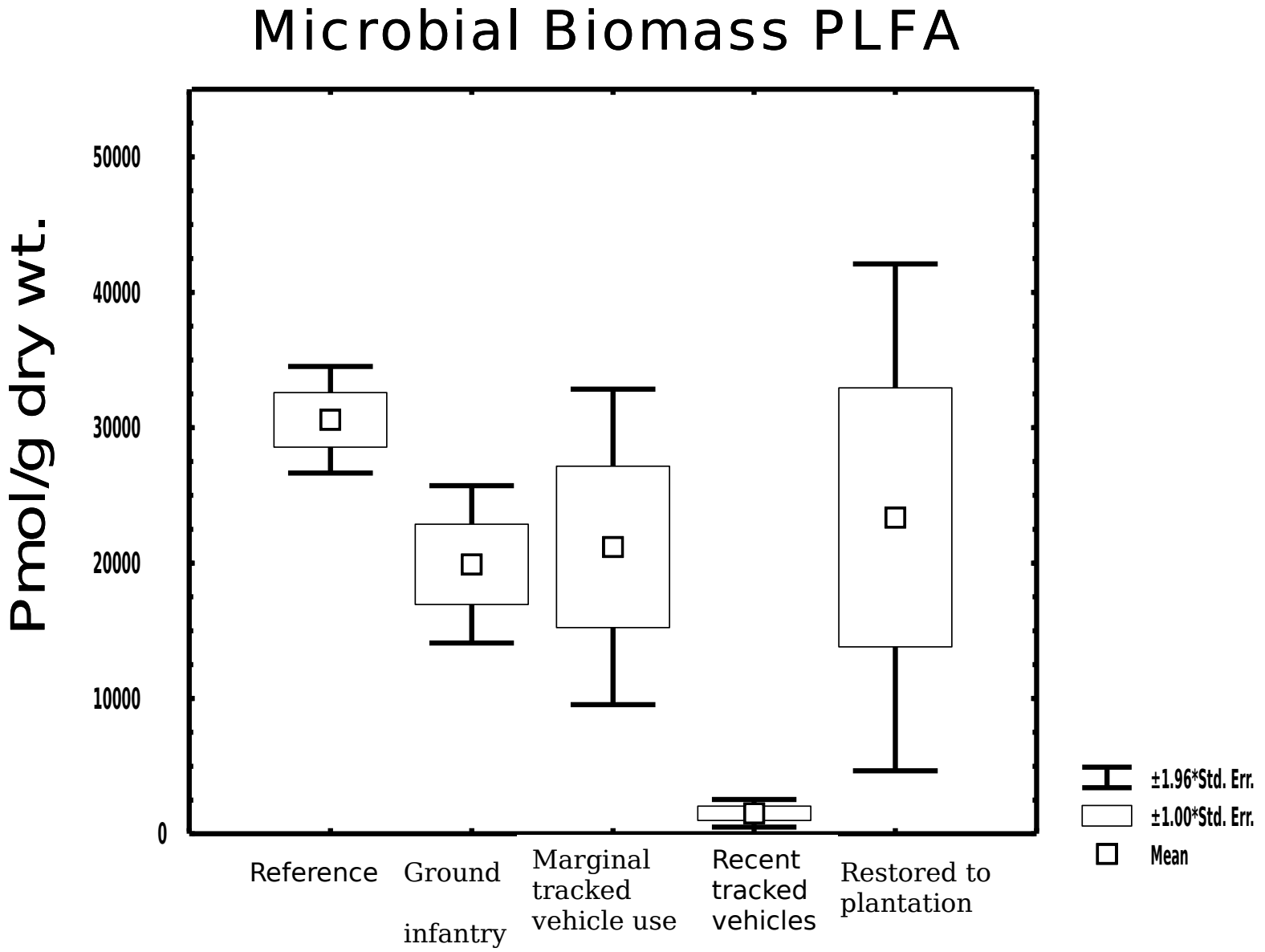
Selected Forest Patch Metrics- ATtiLA

Metric	1827	1974	1983/86	1991	1999
# Forest Patches	3	202	238	248	395
Mean Patch Size	239,833,200	3,000,403	2,467,845	2,291,530	1,408,557
Largest Patch	719,348,400	563,396,400	541,213,200	525,078,000	546,213,600
Shannon Weaver	0.7439	1.4747	1.5274	1.5274	1.6566
Diversity Index	0.6312	0.254	0.2381	0.2338	0.22
Simpson's Diversity Index					

Training Categories Differ According to Life Form Distribution



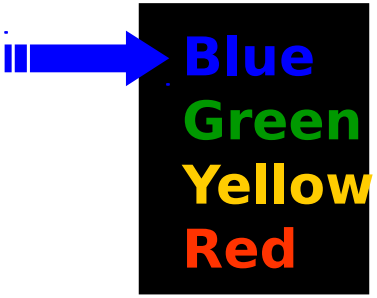
The heavily used site had significantly less microbial biomass.



TAC Recommendations

2002 Fall Meeting

Dale (ORNL) Indicators of Ecological Change



Good progress

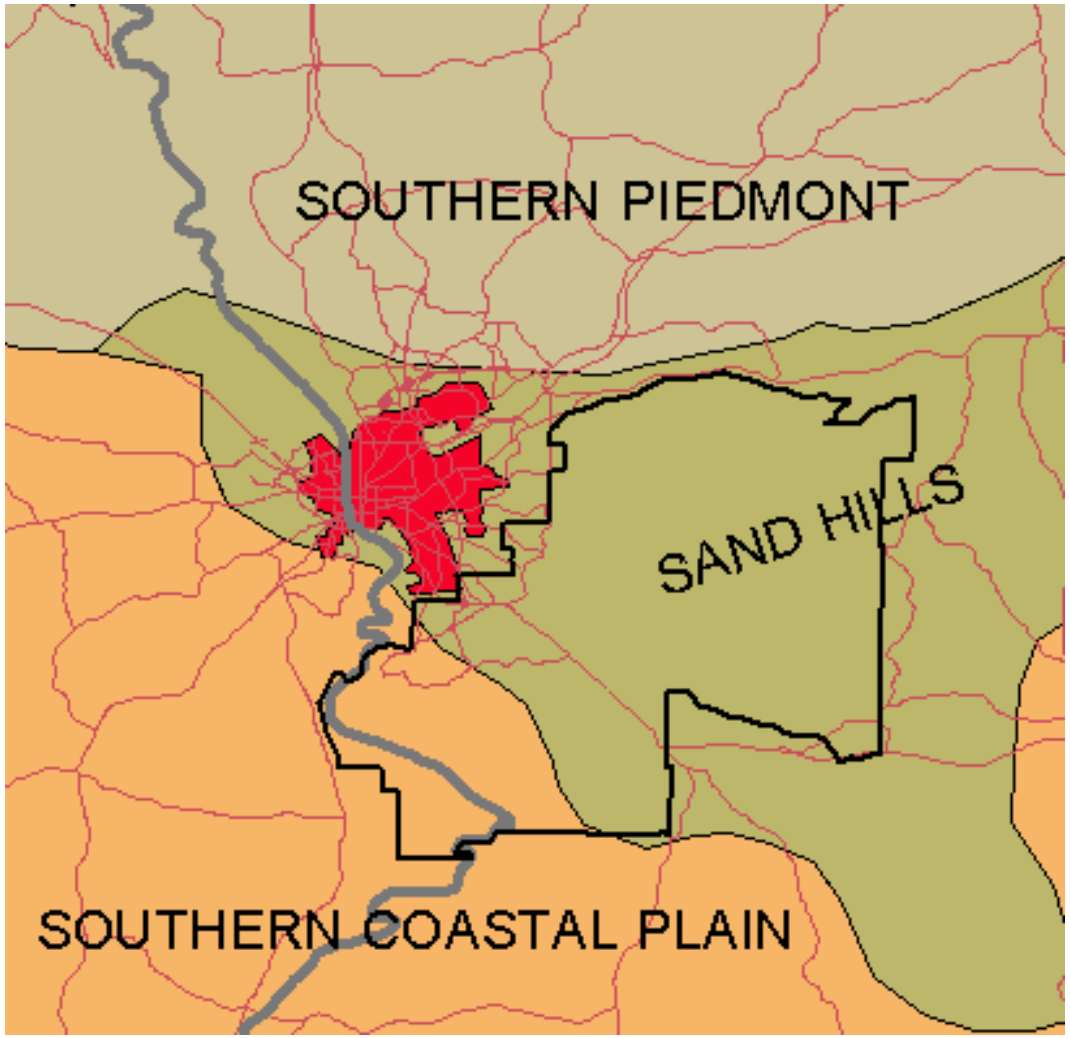
Incorporate vegetation alliance data

Thresholds of Disturbance: Land Managem
Effects on Vegetation and Nitrogen Dynami

Lead: Dr. Beverly Collins, University of Georgia

Purpose: To determine if there are thresholds beyond which upland ecosystems cannot sustain the combined effects of forest management and military traffic disturbance.

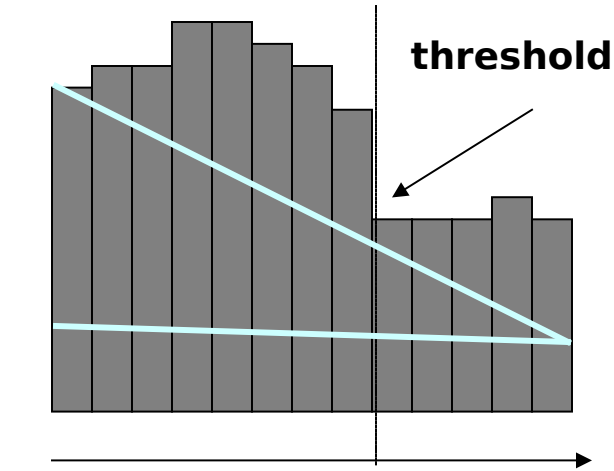
Hypothesis: underlying soil type partly determines forest composition and dynamics, modifies the effects of military

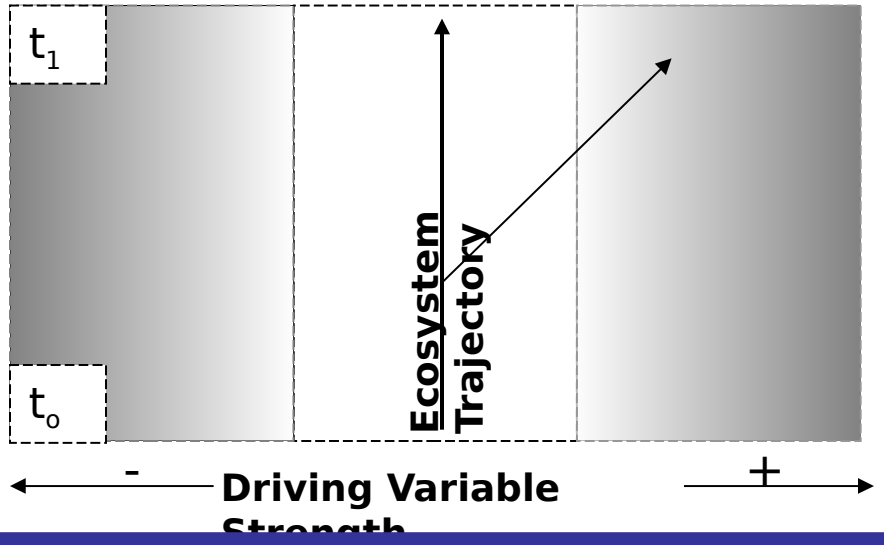


Ft. Benning is Located Along Two Major Ecoregions

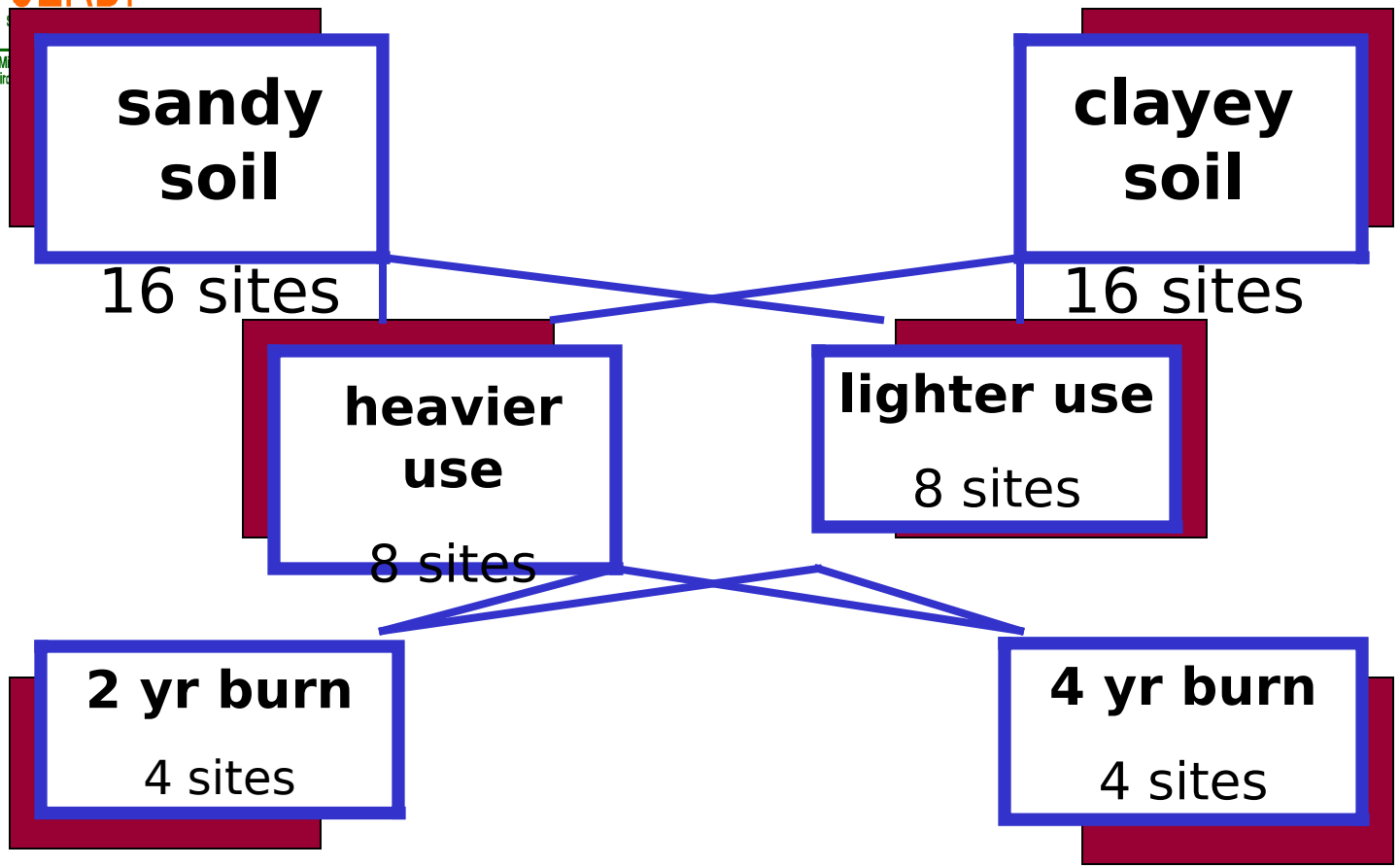
Ecological Thresholds

Threshold: A “sudden change in any property of an ecological system as a consequence of smooth and continuous change in an independent variable.” (Muradian, 2001)





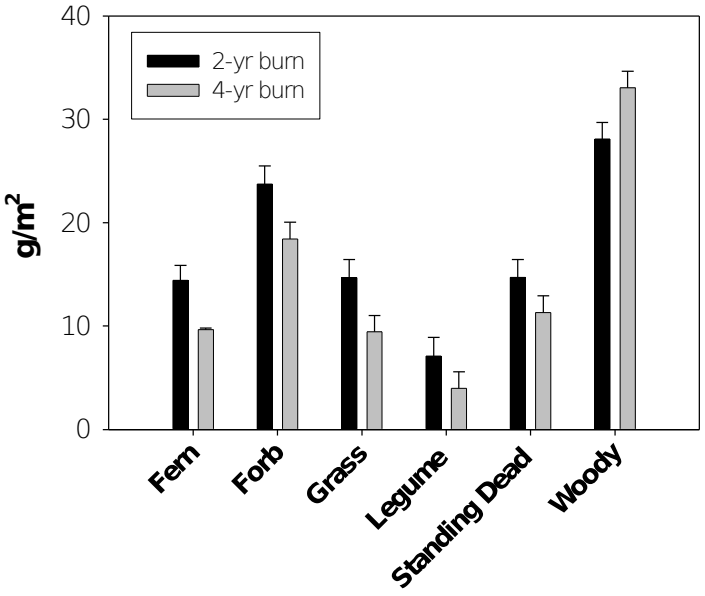
Threshold: A deflection of system response (or an ecological discontinuity) following a stimulus or stressor (Romme et al., 1998)

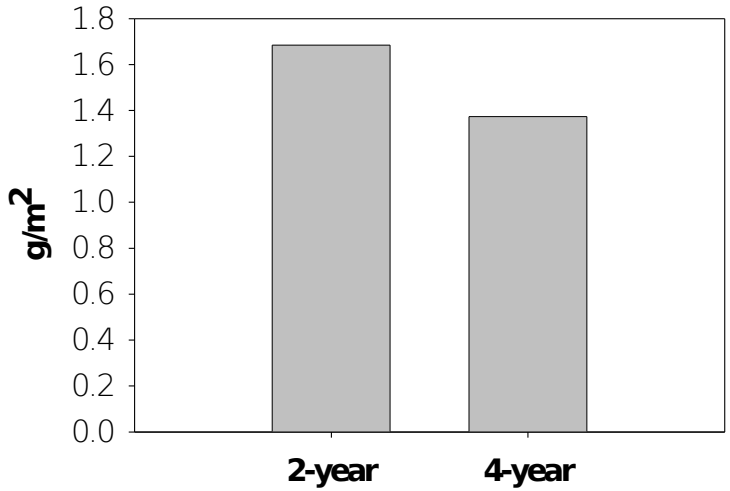


Sites within each burn treatment/military use/soil texture category included a range of time-since-thinning

DESIGN

early results – ground layer biomass





- fire causes a decrease in biomass of woody species, but an increase in fern, forb, grass, and legume biomass.
- fire removes woody species, including woody seedlings that likely collect in intervals between fires
- fire also causes an increase in root biomass, which agrees with the trend for aboveground herbaceous vegetation

SERDP
Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

TAC Recommendations

2002 Fall Meeting

Collins (U Georgia) Thresholds of Disturbance: Land Management Effects on Vegetation and Nitrogen Dynamics

Blue
Green
Yellow
Red

Address issue of fire-adapted communities
in project hypotheses
Arrest regeneration studies

Disturbance of Soil Organic Matter and Nitrogen Dynamics

- **Mr. Charles Garten, Oak Ridge National Lab**

- **Objective: Assess how soil carbon and soil nitrogen dynamics are impacted by land use practices and disturbance regimes, and determine "thresholds" of impacts on recovery processes.**

- **Outcome: Models of soil carbon and nitrogen dynamics to predict the potential recovery of soil organic matter, soil carbon sequestration, and terrestrial sources of nitrogen to aquatic ecosystems.**

Project Flowchart

Predict System Response to Disturbance and Identify Thresholds to Recovery

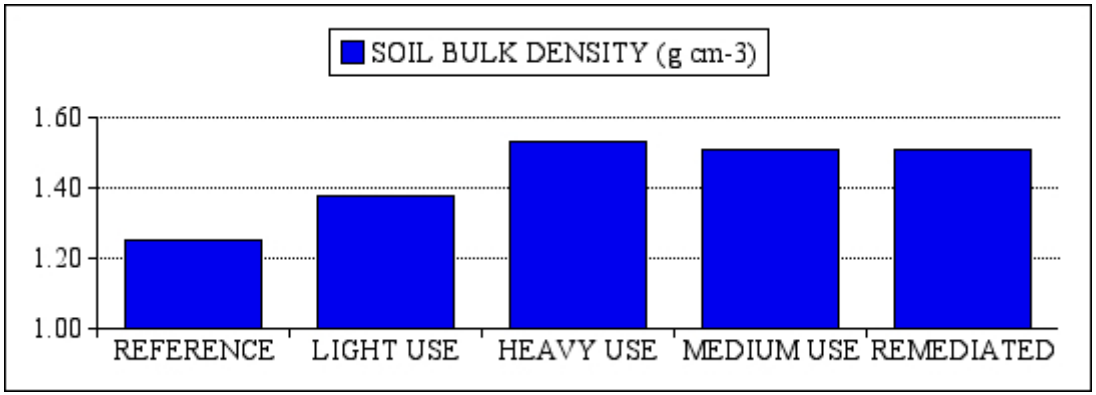
Build mathematical models:
1. spreadsheet models (simple)
2. compartment modelling (complex)

Field measurements from:
1. disturbance gradients
2. different land cover categories
3. forest chronosequences

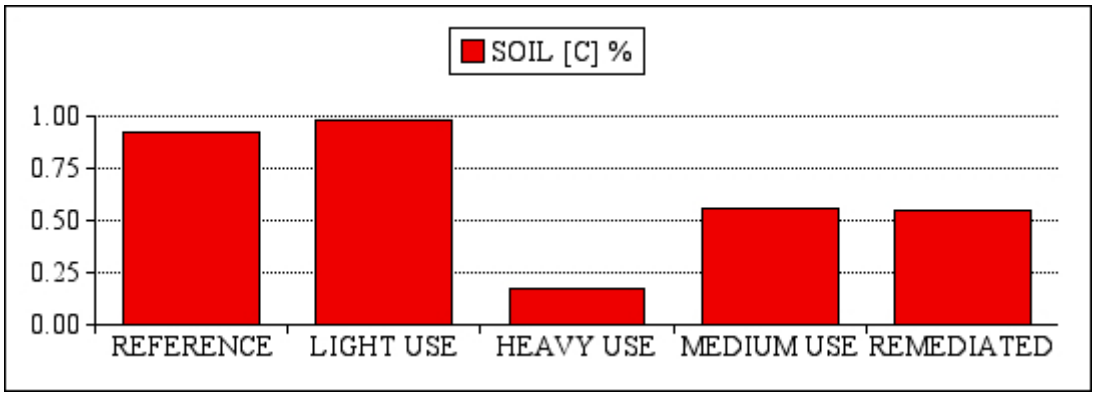
Landscape level analysis of soil C and N dynamics (GIS data + field data + modelling)

Year 1 - Disturbance Gradient

- Surface soil bulk density increased along the disturbance gradient and the change persisted at remediated sites.



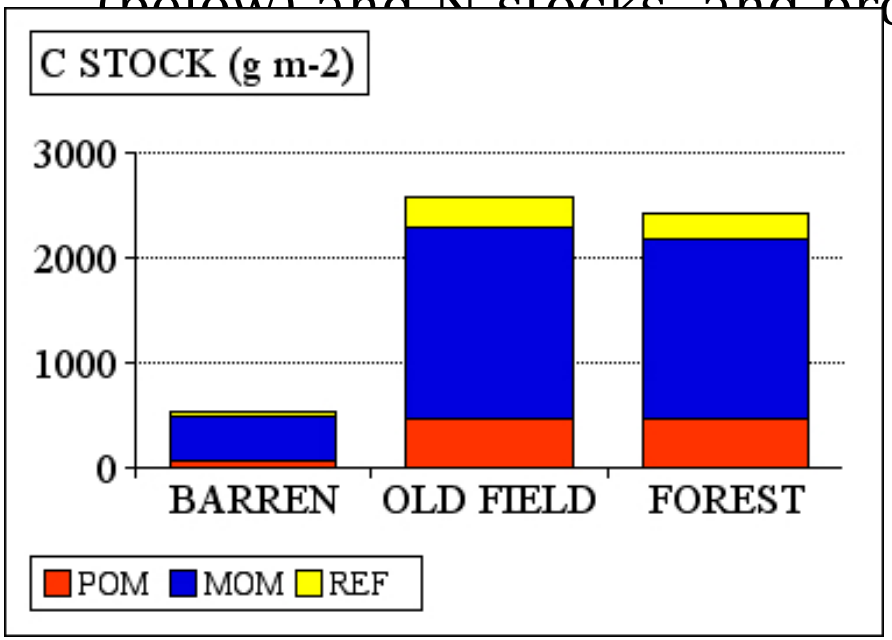
- Surface soil C stocks and soil C:N ratios declined along the disturbance gradient.



- With the exception of surface soil bulk density, measured soil properties at reference and light use sites were similar.
- There was some indication of recovery in soil C stocks at remediated sites.
- Measurements related to C and N are indicators of changes in soil quality.

Year 2 - Land Cover Differences

- Sampling sites classified into 5 land cover types: barren land, transitional vegetation, evergreen forest/plantation, mixed, and deciduous forest
- Land cover has a significant effect on key measures of soil quality including soil bulk density, soil N availability, soil C (below) and N stocks, and properties of the O-horizon



POM = particulate OM

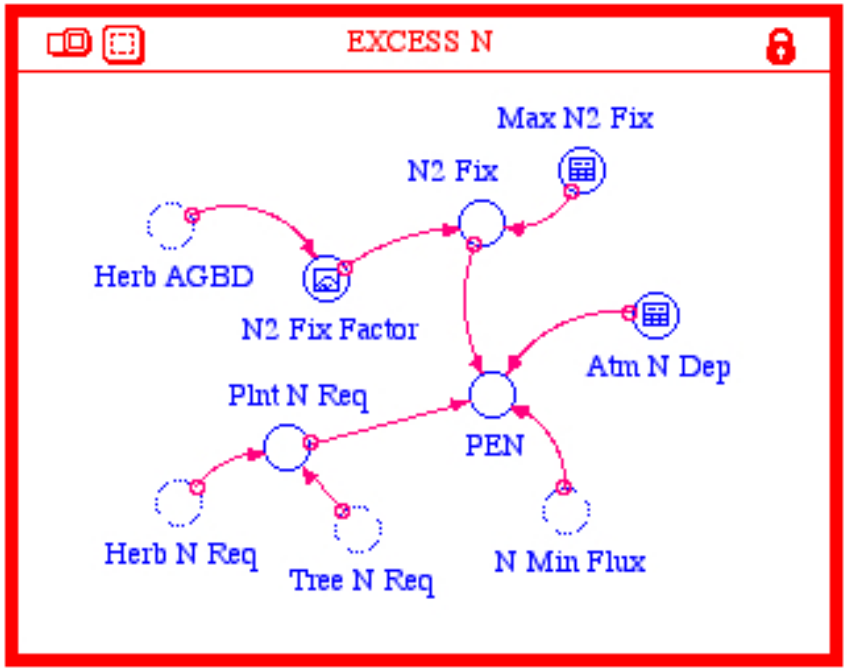
MOM = mineral-associated OM

REF = refractory OM

- Barren land has poor soil quality relative to other land cover types
- The presence of long-term perennial vegetation is

Year 3 - Modeling

- Advantage - modeling can be used to predict the response of an indicator over a range of hypothetical disturbance levels



Submodel for Potential Excess N

- Advantage - models are a framework for integrating information and feedbacks.
- Disadvantage - modeling depends on the availability of appropriate data (model what is measurable).
- Disadvantage - do we know enough about the

TAC Recommendations

2002 Fall Meeting

Garten (ORNL) Disturbance of Soil Organic Matter and Nitrogen Dynamics: Implications for Soil and Water Quality

Blue
Green
Yellow
Red

Good progress
Address nitrogen fixation

DoD EPA DOE SERDP
Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

ERDP's SEMP

Ecosystem Management Project

Integrating Efforts Across Multiple Projects

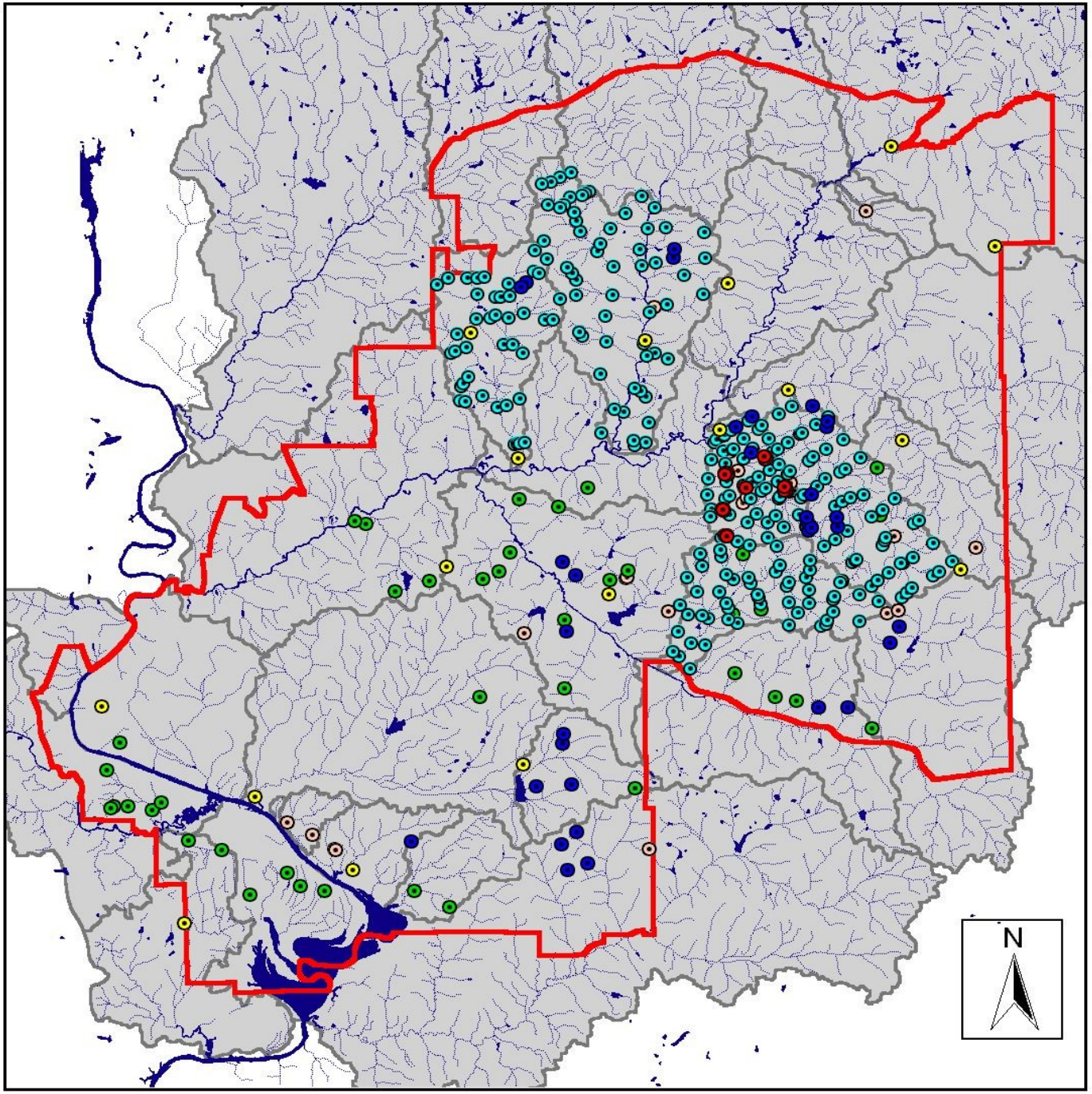
DoD EPA DOE

SERDP

Strategic Environmental Research and Development Program

Improving Mission Readiness Through Environmental Research

SEMP
Field Site Locations
Fort Benning, GA



US Army Engineer
Research and Development Center
Environmental Laboratory
Vicksburg, MS
November 2000

Research Coordination Workshops

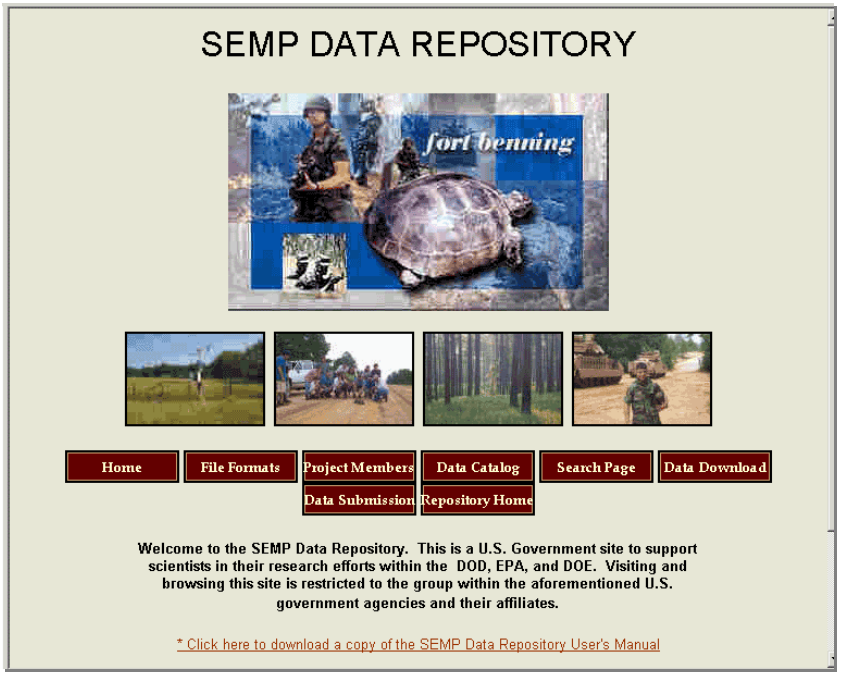
- **Held Annually since 1999**
- **Involve numerous researchers from each of the research teams**
- **Teams brief one another on research hypotheses, approach and early findings**
- **Related projects (region, installation sponsored, other SERDP efforts) also presented**
- **Specific coordination topics addressed at head workshop (e.g. Terrestrial Site Condition Index, historic land use data)**

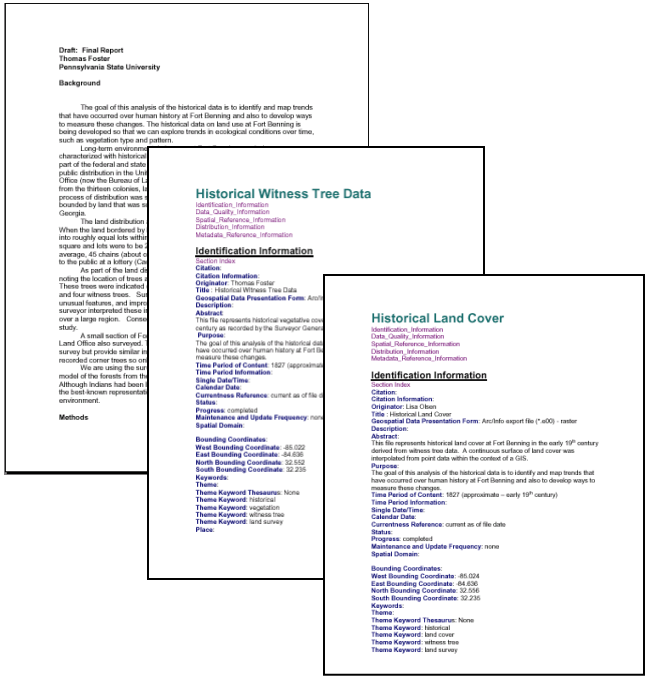
Terrestrial Site Condition Index

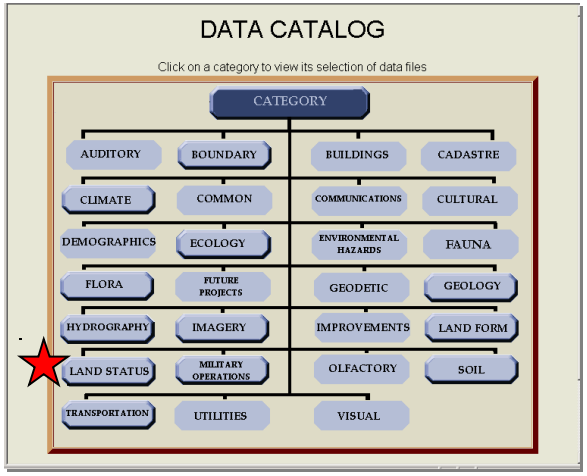
- **A Horizon Soil Depth**
- **Soil/Sediment Carbon**
- **Soil Compaction**
- **Soil/Sediment Nitrogen**
- **Vegetative Structure**
- **Vegetative Species Composition**
- **Historic Land Use**

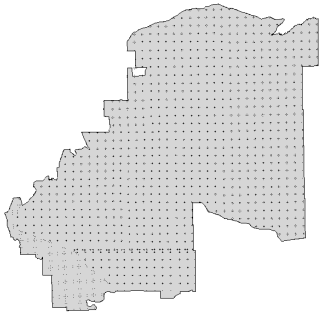
- **Landscape Position (Slope/Aspect)**

The SEMP Data Repository

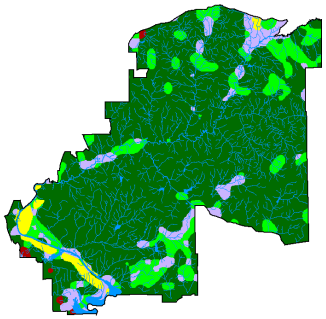

SEMP DATA REPOSITORY
fort benning
Home
File Formats
Project Members
Data Catalog
Search Page
Data Download
Data Submission
Repository Home
Welcome to the SEMP Data Repository. This is a U.S. Government site to support scientists in their research efforts within the DOD, EPA, and DOE. Visiting and browsing this site is restricted to the group within the aforementioned U.S. government agencies and their affiliates.
* Click here to download a copy of the SEMP Data Repository User's Manual





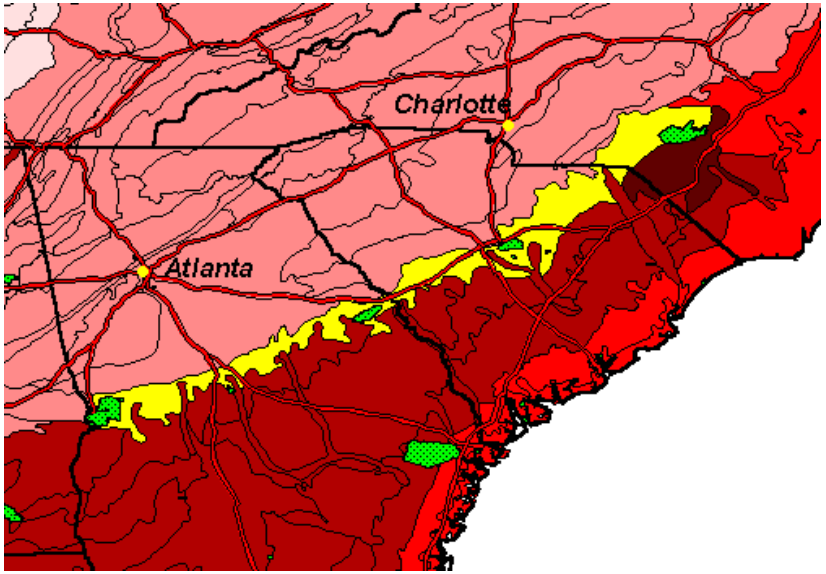


Witness Tree - Point Data



Historical Land Cover

Fall Line Sandhills Initiative



- **Regional Workshop 2001**
- **Fall Line Testbed expansion proposed in 2001; budgeted 2003-2005**
- **New SERDP (SREL) Fall line project initiated in 2002**
- **First Fall Line Testbed proposals currently in review**

Priority research areas (1997 SERDP workshop)
Indicators of ecosystem status
Ecological thresholds
Role of manipulating biogeochemical cycles
Importance of spatial/temporal scales

SEMP Approach

Research Themes

competitive selection

Research Projects

publication and feedback

analysis of findings

integration of efforts

validation and testbedding

Integrated Tools

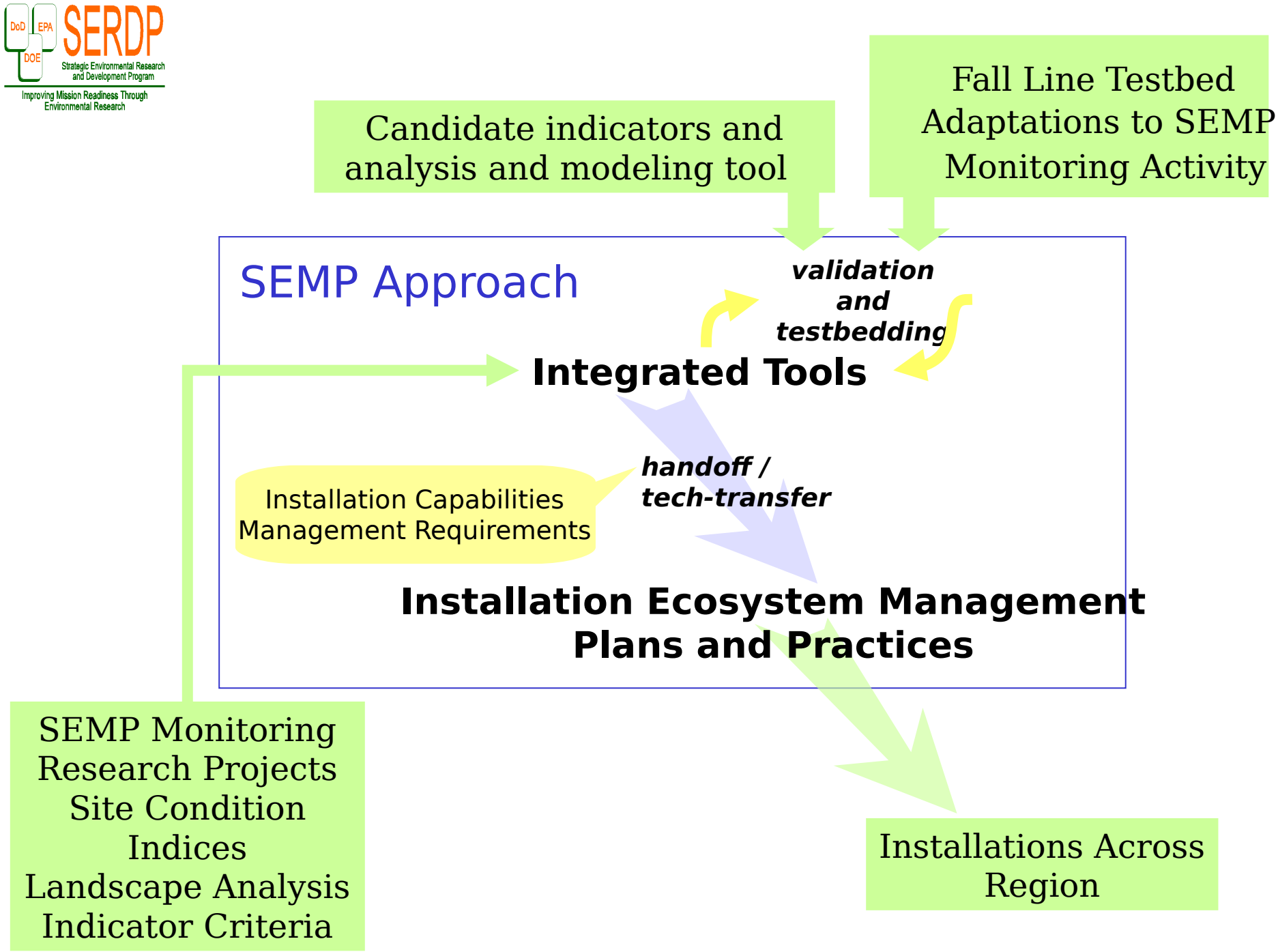
Monitoring Activity (ECMI)
Data Repository
Other Research Projects
Installation Needs and Data

Installation Capabilities
Management Requirements

handoff / tech-transfer

Installation Ecosystem Management Plans and Practices

Next: Franchise SEMP Approach to Other Installations


SERDP
Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research
Candidate indicators and analysis and modeling tool
Fall Line Testbed Adaptations to SEMP Monitoring Activity
SEMP Approach
validation and testbedding
Integrated Tools
handoff / tech-transfer
Installation Capabilities Management Requirements
Installation Ecosystem Management Plans and Practices
SEMP Monitoring
Research Projects
Site Condition Indices
Landscape Analysis
Indicator Criteria
Installations Across Region

SEMP Transitions to Host Installation

Phase	98	99	00	01	02	03	04	05	06	07	08
SEMP Planning											
SEMP Field Research											
SEMP Integration											
Fall Line Test Bed											
SEMP Monitoring		Design					Adapt				
Base Plan					INRMP					INRMP	
Base									Land	Land	

SEMP Transitions to Host Installation

- **Installation Planning Action: Define Ecosystem Management Goals**
- **SEMP Team Collaborates with Installation Staff on Integrated Natural Resources Management Planning**
  - **Identify Critical Ecosystem Processes, Indicators and Linkages related to Goals**
  - **Establish Metrics for Goals**
- **SEMP Team Collaborates with Installation Staff on Plan for Environmental Management System (for Lands/Ranges/Ecosystem)**
  - **Define Process to Measure Progress Against Goals**
  - **Provide Resources for Monitoring and Analysis Requirements to Implement this Process**